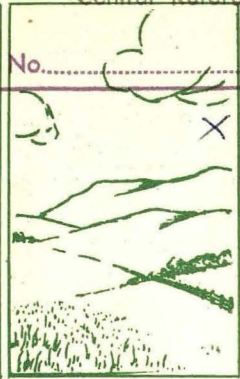


FOREST RESEARCH NOTES

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EFFECT OF WEED COMPETITION UPON

SURVIVAL OF PLANTED PINE AND CHAPARRAL SEEDLINGS

By

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Survival of trees and shrubs in field plantings^{1/} under semi-arid conditions may be determined by the amount of competition for soil moisture and nutrients caused by plants growing in or near the planting area. An opportunity to study the effect of competition between annual plants and planted trees and shrubs was afforded in 1944 on the San Dimas Experimental Forest in southern California. The San Dimas lysimeters^{2/} were soon to be planted to a number of species of native chaparral, and test plantings were made in an adjacent area over a period of several years to develop the proper method of establishing the desired vegetation. The test plantings, made in January, 1944, were designed to answer the question: "Will it be necessary to remove the cover of annual vegetation in order to establish a successful plantation?" The study reported here shows that weeding is necessary.

^{1/} The term "planting" as used in this paper includes both the sowing of seeds and the planting of nursery grown stock.

^{2/} "The San Dimas Lysimeters", by E. A. Colman and E. L. Hamilton, California Forest and Range Experiment Station, Research Note No. 47, 1947.

Four species were used for the study: Coulter pine (Pinus coulteri D. Don), California scrub oak (Quercus dumosa Nutt.), hoaryleaf ceanothus (Ceanothus crassifolius Torr.), and chamise (Adenostoma fasciculatum H. and A.). The test was made in a soil that ranged from sandy loam to sandy clay loam in texture, and from 4 to 6 feet in depth. Growing conditions were good, due to the considerable depth of soil and the abundant winter rainfall (table 1). Average annual rainfall at the study area is 28 inches.

Table 1.- Rainfall at Tanbark Flat,
San Dimas Experimental Forest

Month	: : 1943-44	: : 1944-45	: : 1945-46
- - - - - Inches - - - - -			
October	1.26	1.41	1.18
November	.37	9.41	.53
December	9.79	1.67	13.13
January	1.62	6.73	.39
February	13.96	3.17	2.33
March	3.48	5.33	8.03
April	1.75	.47	.00
May	.00	.00	.16
June	.36	.00	.00
July	.00	.00	.00
August	.00	.51	.00
September	.00	.00	.00
Total annual	32.59	28.70	25.75

The herbaceous growth that covered the test area had been undisturbed for 4 years prior to the study, and had developed a uniformly dense cover. Bromus mollis L., B. arenarius Labill., B. rubens L., B. tectorum L., Festuca megalura Nutt., Lotus strigosus (Nutt.) Green, Trifolium microcephalum Parsh., and Erodium cicutarium L'Her. were the most common species. All these are annuals that mature in the late spring or early summer. Lotus strigosus and Trifolium microcephalum may continue to grow as late as August if there is available water. For the sake of brevity, these annual grasses and herbs will be referred to in this paper as "weeds".

The plants to be studied were set out in the test plots as follow:

Pinus coulteri.— Pine seedlings grown one year in a nursery seed bed were planted in nine rectangular plots of 50 seedlings each. The seedlings were placed in holes spaced 1 foot apart which were dug with a 2-inch soil auger. The individual plots measured 5 by 10 feet, and

were arranged in a row alternating with unplanted strips 4 feet wide. The first, fourth, and seventh plots were hoed and kept free of competing weeds throughout the experiment; those weeds which developed in the second, fifth, and eighth plots were kept clipped to a height of 2 inches above the ground; the weeds in the third, sixth, and ninth plots were allowed to grow without hoeing or clipping.

Quercus dumosa.— Scrub oak was planted by two methods; first, two square plots were planted with 100 seed spots, each spot containing three acorns, and second, two plots were planted with 25 bareroot transplants which had been grown 1 year in pots in the nursery, and removed from the nursery soil just prior to planting. In both methods, one of the two plots was kept free of weeds for the full period of the experiment, but on the other plot the weedy cover was allowed to grow without disturbance. The seed spots were covered with a litter layer and the entire sown area covered with woven wire to protect the seeds from birds and rodents.

Ceanothus crassifolius.— Seeds of hoaryleaf ceanothus were sown in two square plots of 100 seed spots each with approximately 30 seeds per spot. One plot was kept bare and the other allowed to stay weedy. Seed spots were covered with litter and the entire sown area covered with woven wire.

Adenostoma fasciculatum.— Chamise seedlings dug from a 2-year-old burn were planted in two plots of 80 seedlings each (one kept bare and one left weedy). These plants were uniformly pruned to a 2-inch height after planting.

Survival counts of all species were made at intervals during the next three years.

Survival of Plants

Nearly all of the Coulter pine trees survived in the bare plots, only one dying out of the 150 planted (table 2). In the clipped plots 95 survived out of 150 planted, and in the weedy plots only 64. Most of the deaths occurred the first year between July and the end of December. Thus some deaths occurred after the abundant rains of November 1944. Very few deaths occurred during 1945 and 1946. In general deaths started earlier in the weedy plots than in those that were clipped.

Table 2.- Number of Coulter pine seedlings surviving out of
initial planting of 50 per plot

Plot	: treatment	Dates of observation									
		1944					1945			1946	
		7/22	8/17	8/30	9/27	10/19	1/3	4/5	11/16	10/9	
1	Bare	50	50	50	49	49	49	49	49	49	
2	Clipped	50	47	43	33	26	24	22	21	21	
3	Weedy	43	27	22	11	7	3	3	2	2	
4	Bare	50	50	50	50	50	50	50	50	50	
5	Clipped	50	49	47	44	43	41	41	41	41	
6	Weedy	49	47	45	42	41	41	41	39	39	
7	Bare	50	50	50	50	50	50	50	50	50	
8	Clipped	50	50	48	43	38	37	35	33	33	
9	Weedy	50	49	47	38	32	27	26	23	23	

The other species tested (table 3) showed qualitatively the same results, but in all cases survival of transplants in the bare plots was lower than was shown by the Coulter pine. Seed-spot germination and survival was determined by the number of spots that contained one or more living plants at the time of observation. Oak seedlings appeared in fewer seed-spots in the weedy plot than in the bare plot, and the seed-spots showed lower survival and greater second-year losses than did the transplants. Ceanothus showed the lowest seed-spot germination and survival. No seeds germinated in the weedy plot of this species.

Table 3.- Survival of three chaparral species, by type of planting, treatment, and date of examination

Species	Type of planting	Plot treatment	Germi- nation	Date of observation			
				10/19/44	11/20/45	10/9/46	
			Pct.	Pct.	Pct.	Pct.	
Quercus dumosa	Trans-planting	Bare	--	88	84	84	
		Weedy	--	44	36	36	
	Seed spots	Bare	96	55	29	29	
		Weedy	67	41	23	23	
Ceanothus crassifolius	Seed spots	Bare	48	30	26	26	
		Weedy	0	0	0	0	
Adenostoma fasciculatum	Trans-plants	Bare	--	65	59	59	
		Weedy	--	35	31	31	

Discussion and Conclusion

The results of this study show that the presence of weeds reduced survival of all species. The first year appears to be the critical one in determining survival. The fact that most of the pine losses occurred during the dry late summer and fall suggests that competition for water between pine and weeds was probably the causative factor. This suggestion is substantiated by the fact that survival in the clipped plots of Coulter pine was greater than in the weedy plots; transpiration from the clipped weeds would be expected to be less than from the weeds that were growing freely.

In order to find out if differences in available water might provide a clue to the survival of the pines, soil moisture samples were taken on August 29, 1944, in each of the pine plots. This sampling provided a measurement of soil moisture at a time when air temperatures were high and soil moistures near to their minimum. The results of this sampling provided some substantiation of the idea that lack of available water was the critical factor in survival (table 4).

Table 4.- Available water and wilting point of the soils in the
Coulter pine plots at the end of the first summer

		Soil layer							
		0-12 in.		12-24 in.		24-36 in.		36-48 in.	
Plot	Treatment	AW ^{1/}	WP ^{2/}	AW	WP	AW	WP	AW	WP
- - - - - Percent moisture - - - - -									
1	Bare	-1.4	5.3	1.9	4.3	3.9	4.4	5.3	5.4
2	Clipped	-3.1	5.9	1.2	4.4	3.7	4.1	4.6	5.8
3	Weedy	-2.8	5.4	0.0	4.4	2.4	4.2	4.5	4.1
4	Bare	-1.5	4.8	0.8	4.7	2.9	4.9	4.2	4.0
5	Clipped	-1.6	7.2	1.4	6.6	3.3	4.4	4.9	4.2
6	Weedy	-1.6	7.4	1.0	6.0	4.6	5.9	5.8	9.0
7	Bare	-1.8	7.4	0.4	5.2	1.7	7.6	3.6	8.0
8	Clipped	-2.2	7.2	-0.3	5.5	3.3	8.4	7.5	7.2
9	Weedy	-2.2	6.6	-0.7	6.1	0.0	6.6	5.7	8.1

^{1/} AW = Available water (moisture content minus wilting point)

^{2/} WP = Wilting point

In every plot, regardless of treatment, the first foot of soil was devoid of water available to plants. The weedy plots were, on the average, somewhat drier than the bare plots in this layer. Available water was present in the second foot of some plots and not of others. Thus in the first and third trios of plots there was considerably less available water in the weedy than in the bare plots, but in the second trio this was not the case. The average available moisture for the second foot layer of the bare plots was 1.0 percent, for the clipped plots 0.8 percent, and for the weedy plots 0.1 percent. Available water was present in the third foot of all but one weedy plot, and every plot had abundant water in the fourth foot.

Certainly, death of plants cannot be blamed upon lack of water at soil depths greater than 2 feet. There was abundant water in the 2- to 4-foot layer, even at the close of summer. More likely, death was due to some condition in the top two feet of soil (which held most of the absorbing roots) during the spring growing period. At that time the weeds were in their most active growing condition and it can be assumed that transpiration rates were high in both weeds and planted stock. It appears likely that toward the end of that period soil water became scarce in the active root zone and competition for water became severe. Although many plants did not die until much later in the year, they were probably so weakened by weed competition in late spring that they were unable to survive the summer drought.

The study has shown that under conditions of summer drought, good survival of planted stock is dependent upon removal (at least during the first season) of competing annual grasses and herbs.